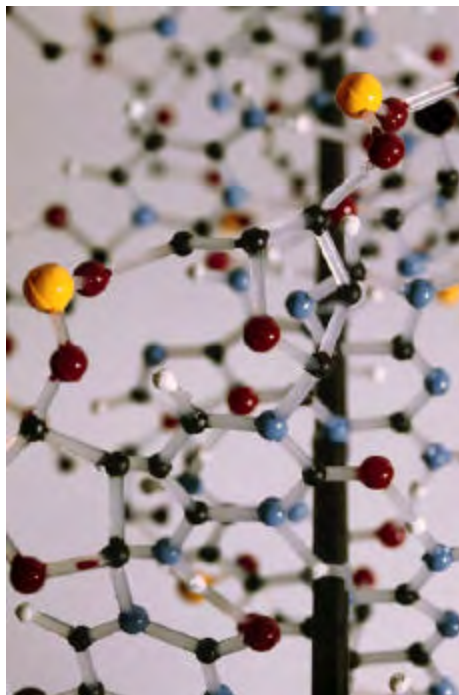


Health Science Biotechnology in Missouri



Additional information is available on-line at:
<http://www.ded.state.mo.us/research>

Health Science Biotechnology in Missouri

Key Findings

- Health science biotechnology employment is concentrated in the core metropolitan areas of the state. It appears that the metropolitan areas of St. Louis (City and County) and St. Joseph (Buchanan County) have high specialization in biotechnology employment.
- Several rural counties also show high specialization in health science biotech employment. It was found that Audrain (Mexico), Henry (Clinton), Howard (Fayette), and Maries (Belle) counties all had unexpectedly high SRs. However, in nominal terms biotech employment was overwhelmingly concentrated in the urban areas of the state.
- In 1999, the health science biotechnology sector directly accounted for 1.05% of total GSP in Missouri (\$1.60 billion). Indirect and induced economic effects attributable to this sector accounted for 1.01% of GSP (\$1.55 billion). Taken together, the health science biotech sector directly and indirectly accounted for 2.07% of total GSP in Missouri (\$3.15 billion).
- In 1999, there were 11,170 health science biotechnology sector jobs in Missouri, with an average wage of \$74,014. This direct employment created an additional 32,736 ancillary jobs in the Missouri economy – for a total impact of 43,906 jobs statewide.
- The creation of 100 jobs in the health science biotech sector would produce \$7,401,378 in wages statewide, resulting in an average wage per job of \$74,013. This direct impact would also create an additional 293 ancillary jobs and \$7,638,102 in wages, for a total impact of 393 jobs and \$15,039,480 in wages across Missouri.
- The creation of new health science biotechnology jobs in the state has positive long-term employment and wage impacts. In 2000, the creation of 100 biotech jobs would result in 510 additional jobs with a total payroll of \$18.5 million. The effect of this impact would decrease by 2005, resulting in 404 additional jobs with a total payroll of \$17.05 million. By 2010 there is some recovery, with the impact resulting in 440 additional jobs with a payroll of \$15.90 million.
- In 2000, the creation of 100 new biotech jobs would result in \$764,000 in additional general sales tax revenues, \$469,200 in additional individual income tax revenues, \$141,200 in additional corporate income tax revenues, and \$91,910 in additional motor fuel sales tax revenues. However, state tax revenue impacts attributable to the creation of 100 new biotech jobs decrease moderately by 2010.

Health Science Biotechnology in Missouri

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I. Overview

Biotechnology is a set of innovations that is revolutionizing health care, food production, and manufacturing. Biotechnology is generally defined as the applied knowledge of biology, and it is not a new phenomenon. Throughout history, humans have selected and manipulated the genomes of plants, animals, and even ourselves. Until now, however, such control could be exerted only at the level of the entire organism. Scientific and technological advances now allow humans to manipulate genomes directly at the level of single genes and their constituents, with a speed and precision that far exceed what natural evolution has been able to achieve over the past 3.5 billion years. Scientific advances made in the mid-20th century laid the foundation for rapid growth in biotechnology in the 1990s. Since the modern biotech sector is relatively new, one can still distinguish companies that are using biotech to develop pharmaceutical, agricultural and industrial products. In fact, a new industry name - life sciences - has already been proposed¹.

Life sciences was trumpeted in the mid-1990s as a way for firms to combine divisions specializing in pharmaceuticals, agriculture, industrial biotech and nutrition to produce new research and products². The life sciences firm was a business strategy to create synergies in basic research, product development and marketing. In the latter part of 2000, however, many former life sciences firms are beginning to sell off unprofitable divisions - particularly ones specializing in agriculture. Agricultural sales have been dented by unstable commodity prices, and the populist backlash against genetically modified foods in Europe².

Researchers at George Mason University³ have defined health science biotechnology industries as those producing medical and botanical products; pharmaceuticals; diagnostic substances; surgical, medical and dental instruments and appliances; medical and dental products; and ophthalmic products. It is argued that this definition of biotechnology is a subset of the overall life sciences sector, which also includes the agricultural and industrial life sciences. In general, the above definition of biotech focuses mainly on the health sciences.

Therefore, this report examines health science biotechnology as a subsector of life sciences. The purpose of this analysis is to determine this sector's impact on Missouri's economy. With recent discoveries in medicine and genetics, we may not yet know the ramifications of these technological changes. Regardless of the changes that will come, Missouri's economy must either play a central role as the industry evolves or step aside and allow others to benefit from the inevitable economic growth that will result.

¹ Biotech Bonanza. *Federal Reserve Bank of Dallas*. July/August 2000.

² Life Sciences: Green and Dying. *The Economist*. 18 November 2000.

³ Stough, R. 1998. *Technology in Virginia's Regions*. Center for Innovative Technologies.

II. Methods

The health science biotechnology sector in Missouri is analyzed using three methods: (1) specialization ratios; (2) input-output models; and (3) structural models. Biotechnology employment and wage data is taken from ES-202 unemployment insurance reporting, collected by the Missouri Department of Economic Development.

The health science biotech sector was defined using a classification scheme developed at George Mason University. According to this definition, biotech firms employ above average numbers of scientific and technical personnel, and possess above average research and development budgets. From this information, Standard Industry Classifications (SICs) were identified as comprising the biotech sector. These industries include medical and botanical products; pharmaceuticals; diagnostic substances; surgical, medical and dental instruments and appliances; medical and dental products; and ophthalmic products. Refer to Appendix A for a full list of SICs.

Specialization ratios (SRs), also known as location quotients, are used to describe the dispersion of the biotech sector across Missouri. SRs measure a county's employment concentration in a given economic sector relative to the state average. SRs are useful because they indicate areas of potential economic growth within the county, or a county's comparative advantage in a given sector. Comparing these ratios over time gives an indication of the relative strengths and weaknesses of the biotech sector.

SRs greater than 1.0 indicate that the county is relatively more specialized in an industry relative to the state as a whole; or that the county has a comparative advantage in that industry. SRs less than 1.0 indicate that the county is less specialized in an industry relative to the state as a whole, which may indicate an area for potential growth; or that the county does not have a comparative advantage in that industry.

It is important to note that SRs measure the proportion of sector employment relative to the state average, and *not* the total number of jobs. Therefore, although St. Louis may have the largest number of health science biotechnology employees, it accounts for only a small percentage of total employment – leading to a small SR. It is also important to note that the following SRs are normalized to the Missouri mean. In general, SRs are most informative when normalized to the national mean. However, national data was not available at this level of sectoral detail.

The formula for a SR is given below:

$$SR_{\text{sector}} = \frac{\left(\frac{\text{SECTOR_EMPLOYMENT}_{\text{county}}}{\text{TOTAL_EMPLOYMENT}_{\text{county}}} \right)}{\left(\frac{\text{SECTOR_EMPLOYMENT}_{\text{state}}}{\text{TOTAL_EMPLOYMENT}_{\text{state}}} \right)}$$

The IMPLAN **input-output model** is utilized to estimate the economic impacts of health science biotechnology in Missouri. IMPLAN is a well-established input-output model that examines the economic relationships among businesses, and between businesses and consumers. The model estimates how changes in one or several economic sectors affects an entire economy.

IMPLAN derives three types of economic effects that permit one to assess the impact of the biotech sector: *direct effects* are economic impacts directly attributable to biotech; *indirect effects* are business-to-business economic impacts; and *induced effects* are business-to-business and business-to-consumer economic impacts (spending of discretionary income by employees). While IMPLAN is a powerful tool in examining economic changes at the local level, it is limited in that it cannot predict long-term effects. It only offers a snapshot of an area's economy at one point in time, and is therefore relatively static.

The REMI Missouri Multi-Regional **structural model** is utilized to forecast economic impacts at the regional and state level. REMI is a comprehensive economic forecasting and policy analysis model. The model incorporates a complete economic history of the state and forecasts data specific to Missouri. The model also has thousands of policy variables that can be used to show the effects of a broad range of economic development policies. The dynamic structure of the model provides the capability to evaluate tax and other changes that affect costs as an aspect of these policies. The dynamic properties of the model also show medium and long-term effects, in addition to short-term effects, on the economy of Missouri. Further, REMI is able to forecast economic impacts for Missouri's 15 economic regions.

Lastly, the list of health science biotechnology companies was developed using information obtained from Dun and Bradstreet.

III. Health Science Biotechnology in Missouri

Sector Overview

The health science biotechnology sector includes industries that produce medical and botanical products; pharmaceuticals; diagnostic substances; surgical, medical and dental instruments and appliances; medical and dental products; and ophthalmic products.

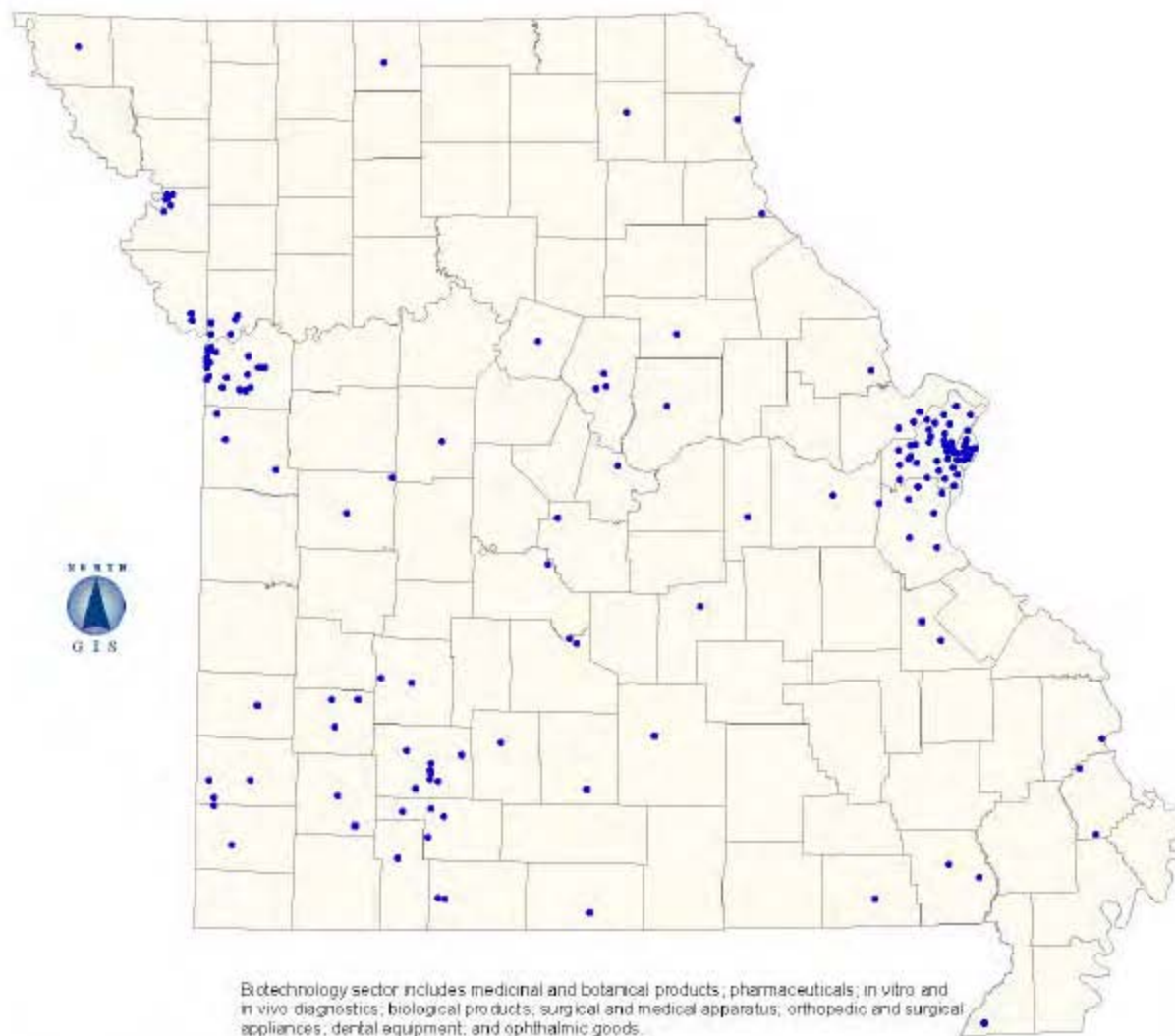
In Missouri, the ten largest firms are located in the metropolitan areas of the state, with over half the firms located in the St. Louis metropolitan area. These ten firms mainly produce pharmaceuticals, surgical and medical instruments, and biological products. Refer to Table 1 and the map below.

Table 1
Largest Employers in the Health Science Biotechnology Sector in Missouri, 1999

Firm	City	Estimated Employment	Estimated Sales	Industry
Mallinckrodt Inc	Saint Louis	1749.5	NA	Pharmaceutical preparations
Forest Pharmaceuticals Inc	Earth City	749.5	\$374.9 Million	Pharmaceutical preparations
Bausch & Lomb Surgical Inc	Saint Louis	749.5	NA	Ophthalmic goods
Sigma Chemical Company	Saint Louis	749.5	\$74.9 Million	Biological products
American Cyanamid Company	Hannibal	749.5	NA	Pharmaceutical preparations
Aventis Pharmaceuticals Inc	Kansas City	749.5	NA	Pharmaceutical preparations
Tyco International (US) Inc	Saint Joseph	749.5	NA	Surgical and medical instruments
Mallinckrodt Inc (de Corp)	Maryland Heights	374.5	NA	Surgical and medical instruments
Allied Healthcare Products	Saint Louis	374.5	\$74.9 Million	Surgical and medical instruments
Boehringer Ingelheim Vetmedica	Saint Joseph	374.5	\$174.9 Million	Biological products

Source: Dun and Bradstreet

Biotechnology Sector Location of Firms



Source: Dun and Bradstreet

Analysis of SRs indicate that health science biotechnology employment is generally concentrated in the core metropolitan areas of the state and in several rural counties. It appears that the metropolitan areas of St. Louis (City and County) and St. Joseph (Buchanan County) have high specialization in biotechnology employment. Surprisingly, Kansas City (Jackson County) only showed above average specialization in biotech employment. However, in nominal terms employment was concentrated in St. Louis, Kansas City, St. Joseph and Springfield.

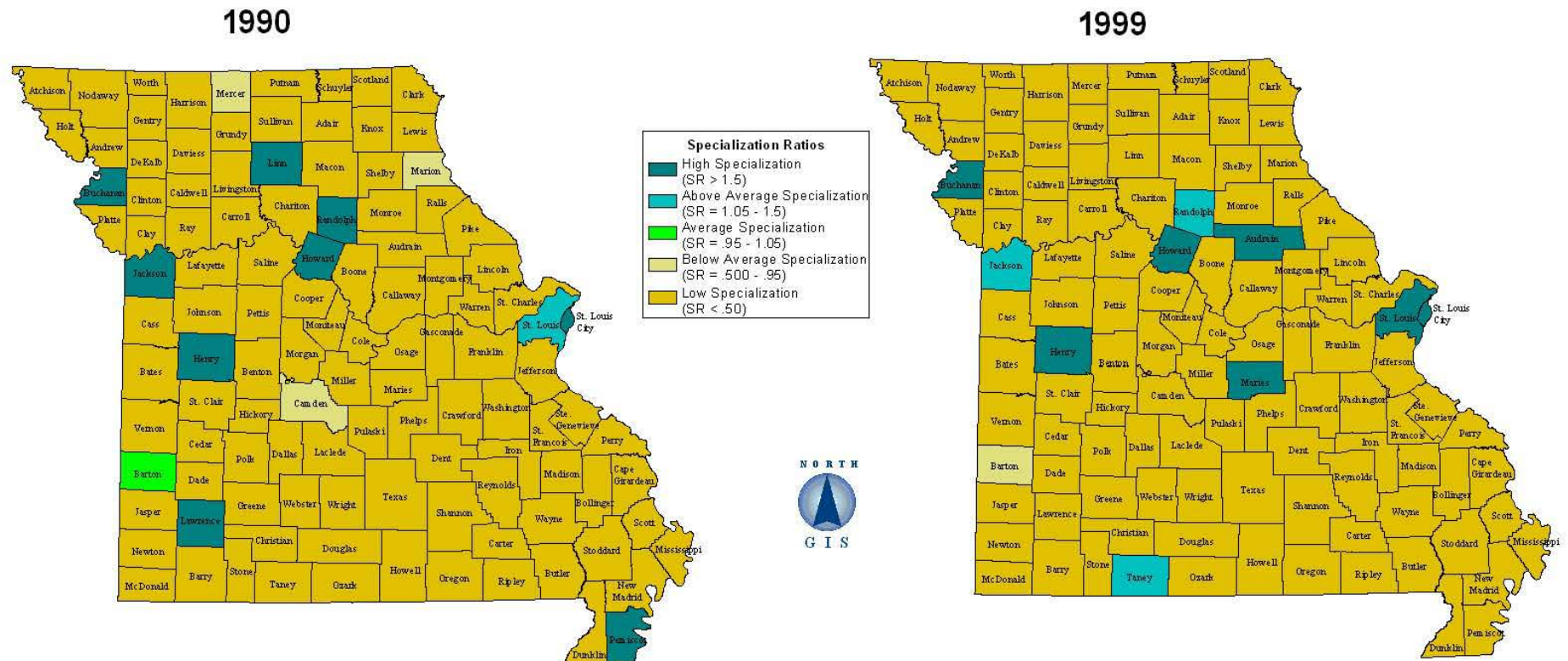
Several rural counties also showed high specialization in biotech employment. For instance, Audrain (Mexico), Henry (Clinton), Howard (Fayette), and Maries (Belle) counties all had unexpectedly high SRs. However, in nominal terms biotech employment was overwhelmingly concentrated in the metropolitan areas of the state.

Health science biotechnology wage specializations in metropolitan areas followed the employment trend. It was found that St. Louis, Kansas City, and St. Joseph all had high concentrations of biotech wages. In nominal terms, wages were also concentrated in the above areas, with the addition of Springfield.

Several rural counties also showed high specialization in biotech wages. Audrain, Henry, Howard and Maries counties all showed high wage specialization; and Taney County showed above average specialization. In nominal terms, biotech wages were concentrated in the above rural areas, with the addition of Marion (Hannibal), Randolph (Moberly) and Taney (Branson) counties. It appears that biotech wages are more dispersed across rural Missouri than biotech jobs.

In general, health science biotechnology employment and wages are located in the metropolitan areas of the state. Recall that SRs measure the proportion of sector employment relative to the state average, and **not** the total number of jobs. The maps below outline employment and wages in the biotechnology sector.

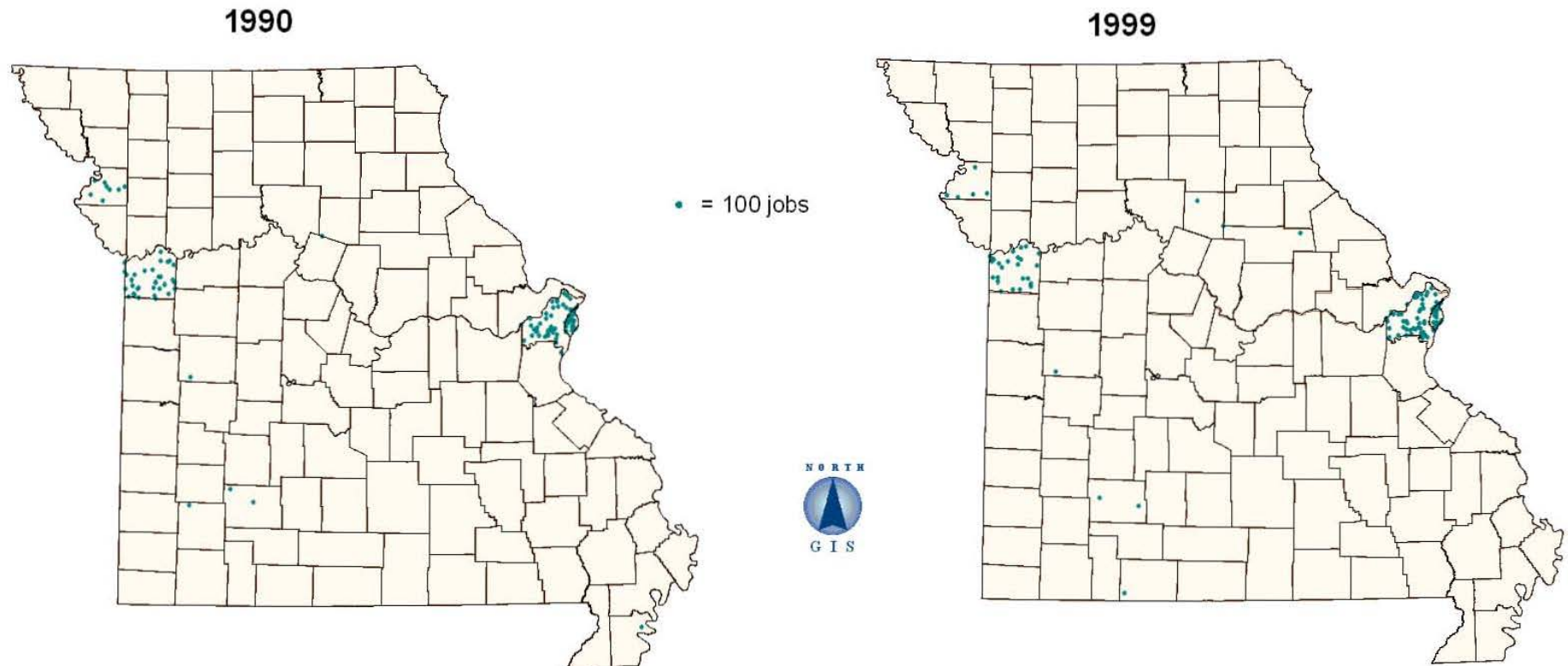
Biotechnology Sector Employment Specialization Ratios



Biotechnology sector includes medicinal and botanical products; pharmaceuticals; in vitro and in vivo diagnostics; biological products; surgical and medical apparatus; orthopedic and surgical appliances; dental equipment; and ophthalmic goods.

Source: ES-202, Missouri Department of Economic Development

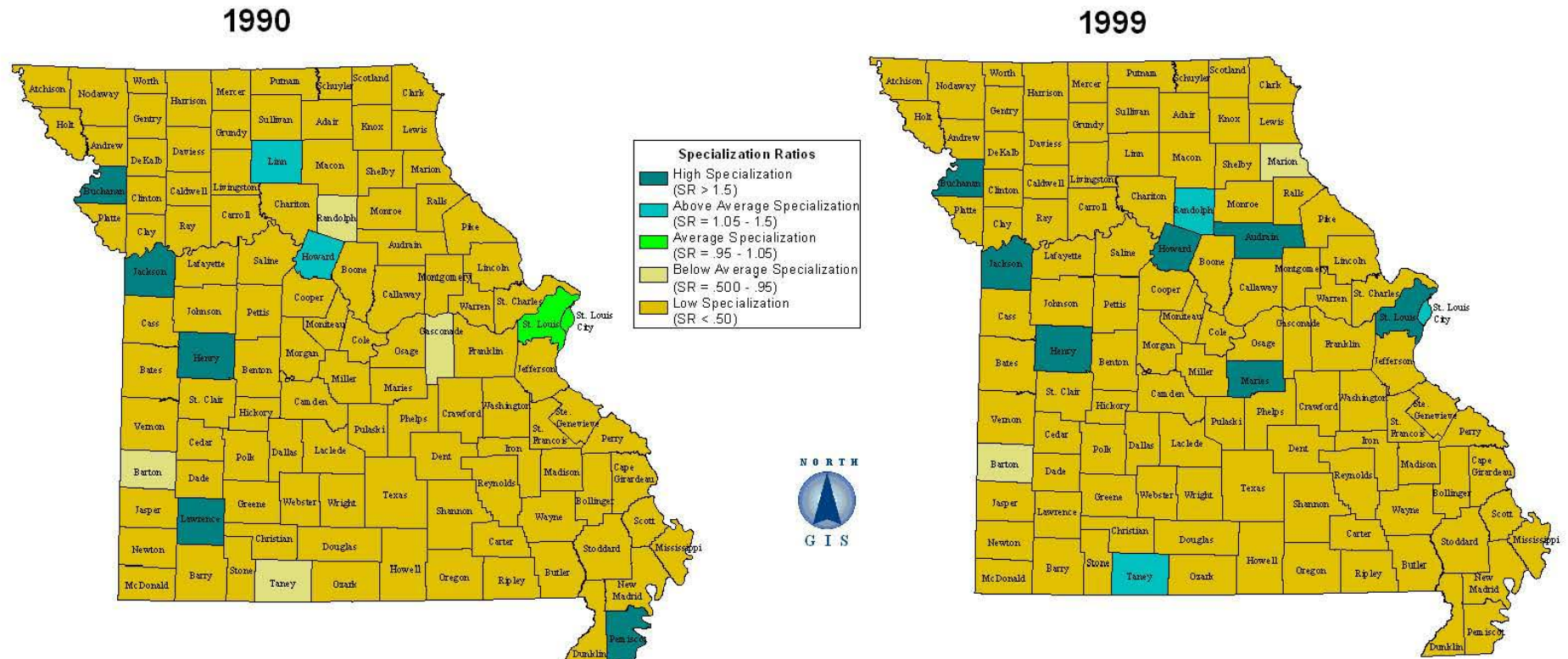
Biotechnology Sector Employment



Biotechnology sector includes medicinal and botanical products; pharmaceuticals; in vitro and in vivo diagnostics; biological products; surgical and medical apparatus; orthopedic and surgical appliances; dental equipment; and ophthalmic goods.

Source: ES-202, Missouri Department of Economic Development

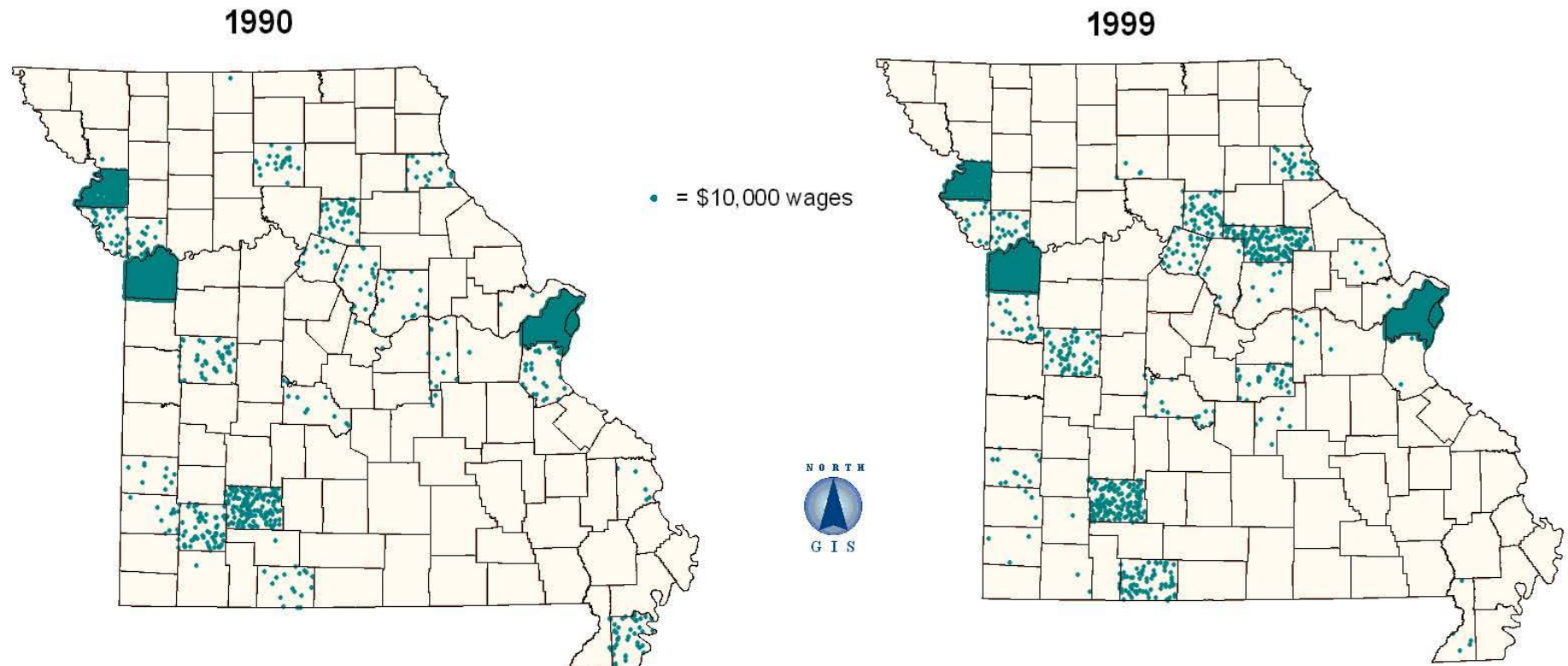
Biotechnology Sector Wage Specialization Ratios



Biotechnology sector includes medicinal and botanical products; pharmaceuticals; in vitro and in vivo diagnostics; biological products; surgical and medical apparatus; orthopedic and surgical appliances; dental equipment; and ophthalmic goods.

Source: ES-202, Missouri Department of Economic Development

Biotechnology Sector Wages



Biotechnology sector includes medicinal and botanical products; pharmaceuticals; in vitro and in vivo diagnostics; biological products; surgical and medical apparatus; orthopedic and surgical appliances; dental equipment; and ophthalmic goods.

Source: ES-202, Missouri Department of Economic Development

Gross State Product

In terms of Gross State Product (GSP) in 1999, the health science biotechnology sector directly accounted for 1.05% of total GSP in Missouri (\$1.60 billion). Indirect and induced economic effects attributable to the biotech sector accounted for 1.01% of GSP (\$1.55 billion). Taken together, in 1999 the biotech sector directly and indirectly accounted for 2.07% of total GSP in Missouri (\$3.15 billion).

It is important to note that the model assumes 100% of industry inputs (labor, materials, etc.) are purchased from Missouri firms. According to IMPLAN estimates, the biotech sector purchases only 55.8% of its inputs from firms within the state. Refer to Table 2.

Table 2
Health Science Biotechnology Gross State Product in Missouri, 1999
 Assumes 100% Local Impact.

SECTOR	PERCENT GROSS STATE PRODUCT			
	Direct	Indirect	Induced	TOTAL
Biotechnology	1.05	0.07	0.00	1.12
Agriculture	-	0.00	0.00	0.00
Mining	-	0.00	0.00	0.00
Construction	-	0.01	0.01	0.02
Manufacturing	-	0.06	0.02	0.08
Transport, Comm. & Public Utilities	-	0.05	0.05	0.09
Retail/Wholesale Trade	-	0.11	0.14	0.25
Finance, Insur. & Real Estate	-	0.04	0.14	0.18
Services	-	0.13	0.16	0.29
Government	-	0.00	0.01	0.01
Other	-	0.00	0.00	0.00
TOTAL	1.05	0.48	0.53	2.07

Source: ES202, IMPLAN

Employment and Wage Impacts

In 1999, there were 11,170 health science biotechnology sector jobs in Missouri, with an average wage per job of \$74,014. This direct employment created an additional 32,736 ancillary jobs in Missouri's economy – for a total impact of 43,906 jobs statewide.

Apart from biotechnology, several other sectors experienced a positive economic impact. The Services sector experienced an increase of 14,320 jobs with an average wage of \$22,545. The Retail and Wholesale Trade sector also experienced an increase of 9,752 jobs with an average wage of \$22,001. Although the employment impact was greatest on these two sectors, the average wage per job was quite low - indicating a moderate overall economic impact.

Additionally, several other sectors experienced modest job increases, but the average wage for those jobs was high. The Finance, Insurance and Real Estate sector experienced an increase of 2,264 jobs with an average wage of \$29,844. The Manufacturing sector also experienced an increase of 2,049 jobs with an average wage of \$39,848.

It appears that the Mining, Government and Agriculture sectors are least affected by biotech employment in Missouri. This indicates that biotech employment is not closely allied with these sectors. Refer to Table 3.

Table 3
Health Science Biotechnology Employment in Missouri, 1999

Assumes 100% Local Impact.

SECTOR	EMPLOYMENT			
	Direct	Indirect	Induced	TOTAL
Biotechnology	11,170.00	662.1	45.8	11,877.90
Agriculture	0.0	113.1	257.3	370.4
Mining	0.0	5.9	4.5	10.4
Construction	0.0	571.9	361.4	933.4
Manufacturing	0.0	1,409.60	639.8	2,049.30
Transport, Comm. & Public Utilities	0.0	978.5	735.2	1,713.70
Retail/Wholesale Trade	0.0	2,577.50	7,174.10	9,751.60
Finance, Insur. & Real Estate	0.0	687.9	1,575.90	2,263.80
Services	0.0	6,255.70	8,064.00	14,319.60
Government	0.0	124.5	233.6	358.1
Other	0.0	0	257.5	257.5
TOTAL	11,170.00	13,386.70	19,349.10	43,905.70

Source: ES202, IMPLAN

The economic impact of new health science biotechnology jobs in Missouri is substantial. For instance, the creation of 100 jobs in the biotech sector would result in an average wage per job of \$74,013. This direct impact would create an additional 293 ancillary jobs in the economy, for a total impact of 393 jobs in Missouri.

Apart from the biotechnology sector, two ancillary economic sectors would be most significantly affected by the direct impact of 100 biotech jobs. The Services sector would experience an increase of 128 jobs with an average wage of \$22,544. Also, the Retail and Wholesale Trade sector would experience an increase of 87 jobs with an average wage of \$22,001. Although the employment impact was greatest on these sectors, the average wage per job was quite low - indicating a moderate overall economic impact.

Additionally, several other sectors would experience modest job increases, but the average wage for those jobs would be higher. The Manufacturing sector would experience an increase of 18 jobs with an average wage of \$39,949. The Transportation, Communications and Public Utilities sector would experience an increase of 15 jobs with an average wage of \$37,545.

It appears that several ancillary sectors would only be marginally affected by the direct impact of 100 biotech jobs. The Mining (increase of 0.1 jobs) and Agriculture (increase of 3 jobs) sectors would experience only small job increases. This indicates that biotech employment is not closely allied with these sectors. Refer to Tables 4 and 5.

Table 4
Employment Impacts of the
Health Science Biotechnology Sector in Missouri, 1999
Per 100 Job Increase. Assumes 100% Local Impact.

SECTOR	EMPLOYMENT			
	Direct	Indirect	Induced	TOTAL
Biotechnology	100.0	5.9	0.4	106.3
Agriculture	0.0	1.0	2.3	3.3
Mining	0.0	0.1	0.0	0.1
Construction	0.0	5.1	3.2	8.4
Manufacturing	0.0	12.6	5.7	18.3
Transport, Comm. & Public Utilities	0.0	8.8	6.6	15.3
Retail/Wholesale Trade	0.0	23.1	64.2	87.3
Finance, Insur. & Real Estate	0.0	6.2	14.1	20.3
Services	0.0	56.0	72.2	128.2
Government	0.0	1.1	2.1	3.2
Other	0.0	0.0	2.3	2.3
TOTAL	100.0	119.8	173.2	393.1

Source: IMPLAN

Table 5
Payroll Impacts of the
Health Science Biotechnology Sector in Missouri, 1999
 Per 100 Job Increase. Assumes 100% Local Impact.

SECTOR	PAYROLL			
	Direct	Indirect	Induced	TOTAL
Biotechnology	7,401,378	461,846	30,642	7,893,866
Agriculture	0	8,003	13,358	21,362
Mining	0	1,181	453	1,634
Construction	0	148,522	90,041	238,563
Manufacturing	0	525,142	205,929	731,072
Transport, Comm. & Public Utilities	0	325,575	248,864	574,439
Retail/Wholesale Trade	0	836,945	1,083,813	1,920,757
Finance, Insur. & Real Estate	0	185,777	419,066	604,843
Services	0	1,214,583	1,675,572	2,890,154
Government	0	51,936	90,690	142,626
Other	0	0	20,165	20,165
TOTAL	7,401,378	3,759,510	3,878,592	15,039,480

Source: IMPLAN

The creation of new health science biotechnology jobs in the state has positive long-term employment and wage impacts. This is ascertained by examining the difference between the baseline projection (no increase of biotech jobs) and the scenario projection (increase of 100 biotech jobs). The differential indicates the number of jobs above or below what would have been expected if no change in the economy had occurred. In 2000, the creation of 100 biotech jobs would result in 510 additional jobs with a total payroll of \$18.5 million. The effect of this impact would decrease by 2005, resulting in 404 additional jobs with a total payroll of \$17.05 million. By 2010 there is some recovery, with the impact resulting in 440 additional jobs with a payroll of \$15.90 million.

First, it appears that the Manufacturing sector would be most positively affected by the impact of 100 new biotech jobs. In 2000, there would be 150 additional manufacturing jobs in the economy, with a payroll of \$8.70 million. By 2010, this increases to 190 additional manufacturing jobs with a payroll of \$8.66 million. Second, the Services sector is also positively affected. In 2000, there would be 132 additional services jobs in the economy, with a payroll of \$3.69 million. However, by 2010 this decreases to 90 additional jobs with a payroll of \$3.27 million. Lastly, the Government sector would grow somewhat rapidly. In 2000, there would be only 9 additional government jobs in the state. However, by 2010 this increases substantially to 38 additional jobs. Refer to Tables 6 and 7.

Table 6
Projected Employment Impacts of the
Health Science Biotechnology Sector in Missouri, 2000-2010

Per 100 Job Increase. Difference from baseline projection.

SECTOR	EMPLOYMENT		
	2000	2005	2010
Agriculture, Forestry, Fishing	3.0	2.2	2.0
Mining	0.5	0.2	0.1
Construction	60.3	34.1	21.4
Manufacturing	149.7	122.5	190.3
Transport, Comm. & Public Utilities	20.1	13.4	11.3
Retail/Wholesale Trade	110.4	82.1	70.7
Finance, Insur. & Real Estate	24.1	17.9	15.5
Services	132.3	97.3	90.0
Government	9.1	33.8	38.4
TOTAL	509.5	403.5	439.7

Source: REMI

Table 7
Projected Payroll Impacts of the
Health Science Biotechnology Sector in Missouri, 2000-2010

Per 100 Job Increase. Difference from baseline projection.

SECTOR	PAYROLL		
	2000	2005	2010
Agriculture, Forestry, Fishing	42,230	38,240	30,820
Mining	23,720	16,720	10,910
Construction	1,802,000	1,292,000	918,900
Manufacturing	8,705,000	8,630,000	8,663,000
Transport, Comm. & Public Utilities	950,800	817,300	642,800
Retail/Wholesale Trade	2,502,000	2,234,000	1,822,500
Finance, Insur. & Real Estate	803,900	700,500	543,600
Services	3,698,000	3,321,000	3,269,000
TOTAL	18,527,650	17,049,760	15,901,530

Source: REMI

Tax Revenue Impacts

The creation of new health science biotechnology jobs in the state has moderate long-term impacts on state tax revenues. In 2000, the creation of 100 new biotech jobs would result in \$764,000 in additional general sales tax revenues, \$469,200 in additional individual income tax revenues, \$141,200 in additional corporate income tax revenues, and \$91,910 in additional motor fuel sales tax revenues. However, state tax revenue impacts attributable to the creation of 100 new biotech jobs decrease moderately by 2010. Refer to Table 8.

Table 8
Projected State Tax Revenue Impacts of the
Health Science Biotechnology Sector in Missouri, 2000-2010
Per 100 Job Increase. Difference from baseline projection.


SECTOR	STATE TAX REVENUES		
	2000	2005	2010
Individual Income Tax	469,200	422,800	394,200
Corporate Income Tax	141,200	130,000	125,700
General Sales Tax	764,400	585,500	500,600
Motor Fuel Sales Tax	91,910	69,640	63,210
TOTAL	1,466,710	1,207,940	1,083,710

Source: REMI

IV. Case Studies

Health Science Biotechnology in Audrain County

Audrain County, in the central region of Missouri, was identified as having a large proportion of health science biotech sector employment and wages relative to the state average. Audrain County is adjacent to the Columbia metropolitan area, yet has experienced a slight decline in population since 1990. Unemployment is lower than the state level, and per capita income is near the state average.

	Audrain County		Missouri	
	Number	Change from 1990	Number	Change from 1990
Population 1999	23,449	-0.6%	5,468,338	6.7%
Unemployment 1999	343	2.6%	95,949	3.4%
Per Capita Income 1999	\$22,765	51.9%	\$25,150	41.7%

The largest biotech firm in Audrain County is TEVA Pharmaceutical Industries. TEVA is a global company with manufacturing sites in Israel, the US and Europe. TEVA develops, manufactures and markets generic and branded human pharmaceuticals, active pharmaceutical ingredients, medical disposables and veterinary products. Corporate headquarters for TEVA is in North Wales, Pennsylvania. The company has three final dosage form manufacturing facilities located in Pennsylvania and New Jersey. The bulk pharmaceutical chemicals facility is located in Mexico, Missouri. The Mexico facility has 150 employees, and annual sales of roughly \$75 million (Dun and Bradstreet 2000).

TEVA sells its products to chains, wholesalers, distributors, hospitals, managed care entities, and government agencies. Key therapeutic areas are the analgesic, anti-infective,

cardiovascular, CNS, dermatological and anti-inflammatory categories. With a century of experience in the healthcare industry, TEVA enjoys a firmly established international presence, operating both independently and through a carefully tailored network of worldwide subsidiaries. In 1999, TEVA posted \$1.28 billion in sales and generating a net income of \$135.5 million (before non recurring expenses). TEVA employs over 6,000 people across the globe. TEVA's scope of activity extends to many facets of the industry, with a primary focus on the manufacturing and marketing of products in Human Pharmaceuticals and Active Pharmaceutical Ingredients (API). These activities, which comprise the core business of the company, account for 90% of TEVA's total sales.

Health Science Biotechnology in Howard County

Howard County, in the central region of Missouri, was identified as having a large proportion of health science biotech sector employment and wages relative to the state average. Howard County is adjacent to the Columbia metropolitan area, yet has experienced little population growth since 1990. Unemployment is at the state level, yet per capita incomes are below the state average.

	Howard County		Missouri	
	Number	Change from 1990	Number	Change from 1990
Population 1999	9,661	0.3%	5,468,338	6.7%
Unemployment 1999	160	3.4%	95,949	3.4%
Per Capita Income 1999	\$19,352	44.5%	\$25,150	41.7%

The largest and only biotech firm in Howard County is Addison Biological Laboratory (ABL). ABL is a privately owned USDA licensed veterinary biologics company located in Fayette. The company has two operational facilities and employs 23 individuals in diagnostic, autogenous, biologics production, research, technical services, quality control, regulatory, gel production, accounting, marketing, sales, and administrative departments. Mr. J. Bruce Addison, President and CEO, started the company over 25 years ago by supplying herd-specific autogenous bacterins to veterinarians attempting to control livestock diseases.

Over the years, ADL has manufactured and marketed many types of animal disease control biologics (the Maxi/Guard® line), growing the company to its current size. In recent years, the company has ventured into international sales and established marketing partners in over 23 countries. A significant percentage of sales now come from overseas accounts. A current major R & D focus is on new swine disease research, designed to substantially increase intranasal respiratory disease control by competitive exclusion means. Significant sales also come from cattle pinkeye bacterin or bulk antigen marketed to large multinational biologics corporations. Eight years ago, the company developed the first home care oral cleansing gel to prevent dental calculus and to control bad breath in pets, including horses. In 1998, ABL launched Maxi/Guard® Zn7™ Derm, a unique internationally patented natural skin conditioner for dermatological conditions of pets. This product has shown significant promise for helping to relieve acral lick granulomas on the extremities of dogs.

V. Implications and Summary

Biotechnology is a set of innovations that is revolutionizing health care, food products, and manufacturing. The health science biotechnology sector is a subset of the overall life sciences sector, which also includes the agricultural and industrial life sciences. Health science biotech industries produce medical and botanical products; pharmaceuticals; diagnostic substances; surgical, medical and dental instruments and appliances; medical and dental products; and ophthalmic products.

In general, health science biotechnology employment is concentrated in the core metropolitan areas of the state and in several rural counties. It appears that the metropolitan areas of St. Louis (City and County) and St. Joseph (Buchanan County) had high specialization in biotechnology employment. Surprisingly, Kansas City (Jackson County) only showed above average specialization in biotech employment. However, in nominal terms employment was concentrated in St. Louis, Kansas City, St. Joseph and Springfield.

Several rural counties also showed high specialization in biotech employment. It was found that Audrain (Mexico), Henry (Clinton), Howard (Fayette), and Maries (Belle) counties all had unexpectedly high SRs. However, in nominal terms biotech employment was overwhelmingly concentrated in the metropolitan areas of the state.

In 1999, the health science biotechnology sector directly accounted for 1.05% of total GSP in Missouri (\$1.60 billion). Indirect and induced economic effects attributable to the biotech sector accounted for 1.01% of GSP (\$1.55 billion). Taken together, the biotech sector directly and indirectly accounted for 2.07% of total GSP in Missouri (\$3.15 billion).

In 1999, there were 11,170 health science biotechnology sector jobs in Missouri. This direct employment created an additional 32,736 ancillary jobs in the Missouri economy – for a total impact of 43,906 jobs statewide. Health science biotechnology is definitely a sector worth targeting, since the economic impacts are quite large. For example, the creation of 100 jobs in the biotech sector would produce \$7,401,378 in wages statewide, resulting in an average wage per job of \$74,013. This direct impact would also create an additional 293 ancillary jobs and \$7,638,102 in wages, for a total impact of 393 jobs and \$15,039,480 in wages across Missouri.

Additionally, the creation of new health sciences biotechnology jobs in the state also has positive long-term employment and wage impacts. In 2000, the creation of 100 biotech jobs would result in 510 additional jobs with a total payroll of \$18.5 million. The effect of this impact would decrease by 2005, resulting in 404 additional jobs with a total payroll of \$17.05 million. By 2010 there is some recovery, with the impact resulting in 440 additional jobs with a payroll of \$15.90 million.

First, it appears that the Manufacturing sector would be most positively affected by the impact of 100 new biotech jobs. In 2000, there would be 150 additional manufacturing jobs in the economy, and by 2010 this would increase to 190 additional jobs. Second, the Services sector is also positively affected. In 2000, there would be 132 additional

services jobs in the economy, and by 2010 this would decrease to 90 additional jobs. Lastly, the Government sector would grow rapidly. In 2000, there would be only 9 additional government jobs, and by 2010 this would increase substantially to 38 additional jobs.

The creation of new health science biotechnology jobs in the state also has positive implications for state tax revenues. In 2000, the creation of 100 new biotech jobs would result in \$764,000 in additional general sales tax revenues, \$469,200 in additional individual income tax revenues, \$141,200 in additional corporate income tax revenues, and \$91,910 in additional motor fuel sales tax revenues. However, state tax revenue impacts attributable to the creation of 100 new biotech jobs decrease moderately by 2010.

Health science biotechnology is an emerging sector in the New Economy, and Missouri is well positioned to play a crucial role in its development. With recent discoveries in medicine and genetics, the biotechnology sector will continue to play a crucial role in the economy, both in Missouri and globally. In addition to provided well paying jobs, this sector will also enhance the quality of life for citizens both within and outside Missouri.

Appendix A

Health Science Biotechnology SICs

SIC	Description
2833	Medicinal Chemicals and Botanical Products
2834	Pharmaceuticals
2835	In Vitro and In Vivo Diagnostic Products
2836	Biological Products, Except Diagnostic Substances
3841	Surgical and Medical Instruments
3842	Orthopedic, Prosthetic and Surgical Appliances and Supplies
3843	Dental Equipment and Supplies
3851	Ophthalmic Goods

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